

Appendix G

Analysis of Benefits and Costs Spreadsheet Elements

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Appendix G. Analysis of Benefits and Costs Spreadsheet Elements

G.1 Assumptions

Table G-1 summarizes the assumptions that were made during the analysis of benefits and costs.

Table G-1. Assumptions Used in Analysis

ASSUMPTIONS		
Technology Acquisition Costs		
Satellite Uplink	(\$ / uplink)	\$ 750,000
Satellite Downlink (w/ 20 "one-touch")	(\$ / downlink)	\$ 20,000
Classroom Conversion to ITV Capability	(\$ / conv.)	\$ 15,000
Production Studio	(\$ / studio)	\$1,000,000
CBT capable machine	(\$ / computer)	\$ 3,500
Multi-media training center (without comp)	(\$ / center)	\$ 5,000
Server Acquisition and Installation	(\$ / server)	\$ 15,000
Usage Fees		
Satellite Air time	(\$ / hour)	\$ 134
Line rate (for "one-touch" system)	(\$ / hour / site)	\$ 4.80
Satellite uplink service charge	(\$ / year / site)	\$ 37,068
Satellite downlink service charge	(\$ / year / site)	\$ 768
Fixed Studio Operations Costs	(\$ / year)	\$ 200,000
Studio Operators Required	(FTEs / studio)	5
Computer Maintenance Fees	(\$ / year)	\$ 350
Course Conversion Costs		
ITV course conversion	Pre-Conv. Crs Hour	\$ 4,000
ITV course update	Post-Conv. Crs Hour	\$ 800
MM / CBT course conversion	Pre-Conv. Crs Hour	\$ 15,000
MM / CBT course update	Post-Conv. Crs Hour	\$ 3,000
MM / CBT course distribution	(\$ / course)	\$ 2,000
Internet course conversion	Pre-Conv. Crs Hour	\$ 5,000
Internet course update	Post-Conv. Crs Hour	\$ 1,000
Travel Assumptions		
Cost for Airline Ticket	(\$ / trip)	\$ 700
Cost of per diem (hotel/meals/etc.)	(\$ / day)	\$ 200
Average Travel Days encountered	(days)	2
Other Assumptions		
Average Federal Salary	(\$ / hour)	\$ 35
Average Contractor Salary	(\$ / hour)	\$ 35
Weighted Average Employee Salary	(\$ / hour)	\$ 35
Weighted Average Annual Salary	(\$ / FTE)	\$ 70,000
Hours Lost for Travel	(hours / trip)	4
Course Delivery Method if not Distance Learning		
Deliver Course on Site with site instructors		84%
Deliver Course on site with traveling Instructor		1%
Send students to other sites		2%
Not Provide Course		13%

Where possible, the assumptions shown in table G-1 were based on DOE's existing experience. The following sections provide a description of each assumption and identify the specific inputs to the model.

G.1.1 Technology Acquisition Costs

The following technology acquisition cost estimates were used in this analysis.

Satellite Uplink Costs: The cost to buy and install satellite uplink dishes and necessary hardware. This analysis assumes the cost to be \$750,000 based on Central Training Academy (CTA) and industry experience.

Satellite Downlink Costs: The cost to buy and install satellite downlink dishes and necessary hardware. This analysis assumes the cost to be \$20,000 per downlink based on the DOE Video Teleconferencing Services report dated July 1996.

Classroom Conversion to ITV Capability Costs: The cost to convert an existing classroom to an ITV capable classroom, which includes the cost of television monitors, desks, "one-touch" student response keypads, and other associated hardware. This cost does not include the cost of building expansion or major building modifications. This analysis assumes the cost to be \$15,000 per classroom.

Production Studio Costs: The cost to equip a production studio for ITV course delivery. This analysis assumes the cost to be \$1,000,000 based on CTA's experience.

MM/CBT Capable Computers: The cost for obtaining computer hardware and software capable of delivering MM/CBT courses. This analysis assumes the cost to be \$3,500 per computer.

Multimedia Learning Center Conversion Costs: The cost of converting an existing classroom to an MM/CBT computer learning center. This analysis assumes the cost to be about \$5,000 per classroom, which does not include the cost of computers.

Server Acquisition and Installation: The cost of acquiring and installing a network server.

G.1.2 Usage Fees

The following usage fees were estimated for this analysis.

Satellite Air Time: The cost of renting satellite air time to broadcast ITV courses. This analysis assumes the cost to be approximately \$134 per hour based on current DOE experience as identified in the DOE Video Teleconferencing Services report dated July 1996.

Terrestrial Line Rate: The "one-touch" student voice and data response system is used in the CTA format to monitor student feedback when delivering courses via ITV. This system transmits

student input back to the host studio via traditional terrestrial phone lines. Each site must be connected at an assumed rate of \$4.80 per hour based on current DOE experience.

Satellite Uplink/Downlink Service Charge: DOE pays a monthly service charge for maintenance of its satellite uplink and downlink equipment. This analysis assumes the monthly service charges to be \$3,089 per month for uplinks and \$64 per month for downlinks based on current DOE experience.

Fixed Studio Operations Costs: The cost of maintaining and operating an ITV production studio. This analysis assumes a cost of \$200,000 per year.

Studio Operators: The number of full-time studio operators required to operate a satellite uplink facility. This analysis assumes five operators.

Computer Maintenance Fees: The cost of maintaining and upgrading computer hardware and software and is assumed to be 10 percent of the initial purchase price. This analysis assumes \$350 per year.

G.1.3 Course Conversion Costs

The following course conversion costs were estimated for this analysis.

ITV Course Conversion Costs: The cost incurred to convert an existing course into an ITV deliverable format. The cost of ITV course conversion ranges from \$4,000 to \$20,000 per hour depending on the complexity of the topic and the quality of the final product. This analysis assumes that a mix of high and low cost training is developed. The actual cost will depend on the percentage of courses converted at each level of complexity.

ITV Course Update: This reflects the cost of updating existing ITV courses to incorporate new material. The cost of updating ITV courses is assumed to be \$800 per course hour.

MM/CBT Course Conversion: The cost incurred to convert an existing course to MM/CBT. The cost varies from \$4,000 to \$15,000 per hour depending on the complexity and quality of the final product. This analysis assumes that course conversion will cost \$15,000 per hour when developed internally.

MM/CBT Course Update: The cost of updating existing courses to reflect new learning objectives and incorporate changes. This analysis assumes a cost of \$3,000 per course hour for updates.

MM/CBT Course Distribution: The cost of duplicating and distributing courses to all DOE organizations. This analysis assumes that 200 copies of each title would be produced at a cost of \$10 per copy for a total cost of \$2,000 per title.

Internet Course Conversion: The cost of converting an existing course into one usable through the Internet. Due to current limitations in the Internet infrastructure, courses must be limited in complexity and are therefore less expensive than traditional MM/CBT courses. For this analysis, the cost of course conversion to an Internet format is assumed to be \$5,000 per course hour.

Internet Course Update: The cost of updating an existing course to reflect changes in learning objectives. This analysis assumes the course update cost to be \$1,000 per hour.

G.1.4 Travel Assumptions

The following costs associated with travel were estimated for this analysis.

Cost of Airline Tickets: This analysis assumes the cost of an average air trip to be \$700.

Cost of Travel Per Diem: This cost covers ground transportation, hotel accommodations, meals, and other sundry expenses associated with travel. For this analysis, \$200 per day was assumed.

Average Travel Days Encountered: The number of travel days associated with attending training at another DOE or non-DOE site. This analysis assumes that 2 days of travel are involved.

G.1.5 Other Assumptions

The following salary and other assumptions were made for this analysis.

Average Federal Salary: The average salary used for cost and benefit calculations was assumed to be \$35 per hour for DOE Federal employees.

Average Contractor Salary: The average salary used for cost and benefit calculations was assumed to be \$35 per hour for DOE contractor employees.

Weighted Average Employee Salary: The weighted average employee salary is based on \$35 per hour.

Weighted Average Annual Salary: The weighted average annual salary is based on a 2,000-hour year and on the average Federal and contractor salary. When calculating the weighted average, it was assumed that there were seven times as many contractor employees as Federal employees.

Hours Lost for Travel: The number of hours per trip that are spent doing non-value added activities such as making travel arrangements, traveling to and from airports, and in-air time. This analysis assumes 4 unproductive hours for each trip.

Partnership Benefits: It was assumed participation in internal and external partnerships will reduce advanced training technology development and delivery costs in the range of 15 to 40 percent during the 5-year approach defined by this business case.

G.1.6 Course Delivery Method if Not Technology-Supported Learning

Courses that are delivered through non-technology-supported learning media were assumed to be performed using one of the following methods.

- Deliver course on student's site using site instructors - 84 percent
- Deliver course onsite, but use an instructor from the organization - 1 percent
- Send student to another site to receive training - 2 percent
- Not provide the training - 13 percent

In addition to the above assumptions, a series of benefits and costs were identified and quantified based on input from the Alternative Characterization worksheet described in section G.2.

G.2 Alternative Characterization

Each alternative utilizes a different mix of training media, which in turn drives the equipment, course conversion, and course delivery needs. To evaluate each alternative, a series of inputs to the analysis of benefits and costs model were used to reflect the unique characteristics of the alternative being considered. The following inputs were used.

Courses Converted: The number of courses that will be converted to each medium being considered (ITV, MM/CBT, Internet). Each course is assumed to be of average length as identified in section G.3.

Satellite Uplinks: The number of satellite uplinks to be acquired.

Satellite Downlinks: The number of satellite downlinks to be acquired.

Classroom Conversion to ITV: The number of classrooms to be converted to an ITV-capable format.

Classroom Conversion to MM/CBT Learning Center: The number of classrooms converted to an MM/CBT-capable learning center.

ITV Production Studios: The number of ITV production studios (generally the same as the number of satellite uplinks).

Partnerships for MM/CBT Course Development: The source of MM/CBT courses. This breakdown impacts the true cost of courses for the Department.

ITV Quality: The general quality of the final product. Some courses will be of the highest quality (and corresponding cost) while others will be of a more cost effective quality. The breakdown between the two extremes impacts the average cost for ITV course conversion.

Percentage of Courses Updated: The percentage of courses that will be updated annually to reflect changes in learning objectives.

Average Student Enrollment: The average number of students enrolled in the “average” course for each delivery method.

Corporate/Non-corporate Approach Multipliers: These multipliers are used to factor in the effect of not using a corporate approach to expand technology-supported learning.

Enrollment (due to Advertisement) - This factor is used to modify the “average” number of students per course when a corporate approach to training is not used. A non-corporate approach will limit the effectiveness of technology-supported learning because not all students will be using the same course catalog resulting in lower average course enrollment.

MM/CBT Conversion Learning Curve - This factor is used to modify the cost of course development to include the effect of a non-coordinated approach to development. Since lessons learned will not be formally shared, many individuals and organizations within the Department will need to re-learn lessons already experienced by others.

Elimination of Redundant MM/CBT Course Development - Another cost of not using a corporate approach is the redundant course development that will likely occur. This multiplier is used to increase the overall course development cost to reflect this inefficiency.

MM/CBT Incompatibility - This factor is used to modify the average course enrollment to reflect the impact of not using a standard MM/CBT training platform.

G.3 Usage Estimates

The third worksheet in the analysis of benefits and costs model was the Usage Estimates worksheet, which includes information pertaining to class size, length, compression ratios, etc.

Number of Organizations Using Each Medium: The number of organizations (e.g., Headquarters, field sites, laboratories) that are assumed to use each medium.

Number of Courses Offered: The number of courses offered in each medium and is based on the “alternative characterization” inputs from above.

Average Course Length: The average course length assumed for each medium.

Course Compression Time: The percentage of post-converted course length to the pre-converted course length. For example, a course that was 10 hours long when taught in a traditional classroom and is 6 hours long when using technology-supported learning has been compressed to 60 percent of its original length.

Pre-converted Course Length: The length of the average course prior to converting to a technology-supported delivery method and is obtained by dividing the post-converted course length by the compression factor.

Average Number of Students: The average number of students assumed to attend each course.

Total Number of Students: The total number of students that take a course using the particular delivery method. It is calculated by multiplying the “average number of students” by the “courses offered.”

Total Hours of Instruction: The total hours of instruction is obtained by multiplying the “total number of students” by the “average course length.”

Students Who Avoid Travel: The number of students who avoid travel by using a technology-supported learning delivery method and is based on the “total number of students” and the percentage that would travel to another location if technology-supported learning was not available.

G.4 Description of Benefits and Costs

The benefits and costs of each alternative were explicitly identified in the detailed benefits and costs worksheets and were divided into the following categories:

- Non-Recurring Benefits (none identified in this analysis)
- Recurring Benefits
- Non-Recurring Costs
- Recurring Costs

Total Capital Invested: The total capital investment needed over the 5-year period. This number is expressed in "real" (fiscal year 1997) dollars and should be adjusted upward slightly to account for inflation when developing capital budgets (as shown in chapter 7).

The following paragraphs provide examples of each type of benefit and cost and identify the specific ones used for this analysis.

G.4.1 Quantifiable Recurring Benefits

Recurring benefits are benefits that will be realized on a continuing basis once the technology-supported learning initiative is underway. The following quantifiable recurring benefits were included in the analysis of benefits and costs.

Air Travel Reduction

Currently, many employees must travel to other DOE or non-DOE facilities to receive or provide training, which often involves air travel and significant per diem expenses (lodging, ground transportation, meals, etc.). An important goal of technology-supported learning is to reduce the amount of training-related travel. Although it was assumed that a relatively low percentage of the total number of students instructed in any particular topic would have to travel, the savings from travel reductions was still significant. This cost was quantified by multiplying the number of students expected to travel by the sum of an average airline ticket and the cost of 2 days per diem.

Avoidance of Lost Time

Another cost associated with travel is the non-productive time spent: 1) arranging travel and lodging accommodations, 2) traveling to and from airports, 3) checking bags and ticketing, and 4) flight time (although this time might be productive in many cases). For this analysis, it was assumed that 4 hours of non-value added time were consumed for each trip. The 4 hours of non-value-added time were multiplied by an average employee salary and the number of students traveling to arrive at the total cost for the Department.

Reduction in Instructor Costs

Expanded use of technology-supported learning can significantly reduce (or eliminate) the need for instructors within the Department. If courses are generally taught using onsite instructors, the use of ITV can reduce the total number of instructors to one or two. Multimedia learning activities eliminate the need for instructors.

Course Compression

Technology-supported learning media have proven to be highly effective techniques for education and training and often result in a reduction in course delivery time when compared to traditional classroom lecture approaches. This reduction in course length results in a significant reduction in student “in-class” time.

G.4.2 Quantifiable Non-Recurring Costs

Non-recurring costs are associated with an investment alternative that does not repeat year after year. Typical non-recurring costs include initial equipment purchases, equipment installation, training, and other one-time costs. The following non-recurring costs were quantified and included in this analysis.

ITV Production Studios

The model being considered for expanded use of technology-supported learning via ITV relies on broadcasting courses over digital satellite and using the “one-touch” system of keypads to monitor students’ progress and feedback. This training requires a production studio including cameras, backdrops, and control consoles. DOE currently has one production studio at the Central Training Academy and is building another at Savannah River Operations. Additional production studios might be required depending on the specific alternative being considered.

Satellite Uplink/Downlinks

Satellite uplinks and downlinks are required to send and receive ITV learning activities. The Department already has one digital satellite uplink facility at CTA and several downlink facilities. The alternatives being considered call for installing additional satellite uplink facilities (when additional production studios are required) and additional downlink facilities to expand the number of sites that have access to training courses.

Classroom Conversion (to ITV Compatible)

In addition to a satellite downlinks, DOE organizations must convert at least one classroom to an ITV-capable classroom if they are to receive satellite broadcasts. The conversion costs cover the installation of television monitors, desks, “one-touch” keypads, and other related electronics. For this analysis, it was assumed that existing classrooms would be converted rather than building dedicated classroom facilities.

Course Conversion (to ITV/Multimedia/Internet Format)

An important non-recurring cost is the initial conversion of classroom courses to a technology-supported learning format. The cost of course conversion varies widely based on the delivery method being used, the topic complexity, and the quality of the final product. The numbers in this analysis are based on the Department’s experience and benchmarking data from other sources. Table G-2 shows a range of course development costs for the primary delivery methods and the conversion cost per hour of pre-converted course length. See appendix J for source information.

Table G-2. Range of Course Development Costs

Delivery Method	Course Conversion (dollars per hour)
ITV	\$2,000-\$14,000
MM/CBT	\$5,000-\$25,000
Internet	\$2,000-\$10,000

Installing Multimedia Learning Centers With Computers

Delivering learning activities using MM/CBT requires the use of a multimedia-capable computer. Although the Department is purchasing multimedia computers, they are not widely available for training. To effectively use MM/CBT as an education and training delivery method, additional learning centers dedicated to MM/CBT training will be required. Each learning center will need between 2 and 25 multimedia computers depending on the number of employees served. For this analysis, it was assumed that each learning center would be equipped with six multimedia computers. The cost for classroom conversion assumes that an existing classroom is available and can be converted rather than building a dedicated facility.

Internet Server Acquisition and Installation

A computer server will be required for maintaining the Internet training program. This cost category is used to identify the cost of additional servers that might be needed by the Department if existing capacity is not adequate.

G.4.3 Quantifiable Recurring Costs

Recurring costs are expected to be incurred on a continuing basis. Examples of recurring costs are equipment operating expenses, ongoing technical support, license agreements, and usage fees. The following costs were explicitly identified in this analysis.

ITV Studio Operation

An ongoing cost of technology-supported learning is the operation of the ITV production studio. The operating costs cover fixed expenses associated with studio and equipment operation and maintenance.

Instructor Preparation

Considerable effort to develop course material, graphics, and other props is required by the instructor prior to delivering an ITV course. This cost category is used to identify these costs.

Satellite Air Time

Satellite air time must be rented for the actual learning activity delivery. The cost of satellite air time was assumed to be \$134/hour and is based on DOE's current experience at CTA.

Site Facilitators for Select ITV Learning Activities

Some learning activities require both classroom lecture type modules as well as hands-on practice. Since the ITV instructor is physically separated from the students, onsite facilitators are required to assist students during the hands-on segments. For this analysis, it was assumed that onsite facilitators would be required for 50 percent of the learning activities delivered through ITV.

Monthly Service Charges for Uplink/Downlink Equipment

Uplink and downlink service charges are paid to ensure equipment reliability. DOE currently pays \$3,089 for each uplink facility and \$64 for each downlink facility per month.

Terrestrial Line Usage

Standard terrestrial lines are used to transmit the "one-touch" keypad signals and students' voice responses back to the host production studio. A terrestrial line usage fee of \$4.80 per hour must be paid for each organization participating in an ITV course.

Course Updates

Updates to course materials will be required when the learning objectives for a training course are updated. To accommodate this change, this analysis assumes that 20

percent of all titles will be updated annually at a cost of 20 percent of the original course conversion cost.

Centralized Help/Hotline for Multimedia Support

To ensure the ease of use of multimedia and computer-based training learning activities, a centralized help hotline will be established to assist students and proctors when setting up and operating equipment and to ensure learning activities are properly loaded and used. The hotline will be operated from one central location.

Site Proctors and System Administrators for Multimedia Learning Centers

Organizations that currently use multimedia learning activities have found that a proctor or system administrator is required to help students load and use MM/CBT learning activities. The proctor also ensures test security is maintained for courses that require completion exams. Although the level of effort required by the site proctor/system administrator varies widely, this analysis assumes that 0.2 full-time equivalents (FTEs) will be required for each learning center.

Course Distribution

In addition to learning activity development, duplication and distribution costs will be incurred for multimedia/CBT learning activities. Learning activity distribution will also be incurred as existing courses are updated to reflect changes in module objectives. This analysis assumes that 200 copies will be produced and distributed for each learning activity at a cost of \$10 per copy.

Computer Hardware/Software Maintenance

Ongoing computer software will be required for MM/CBT computers. This cost category is used to identify (and quantify) this support.

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